

What is claimed is:

1. A method of improving adhesion between the surface of one or more thermoplastic polyolefin elements and a coating material subsequently applied thereto, said method comprising:

- supplying an adhesion promoter;
 - creating a mixture of said adhesion promoter and de-ionized water;
 - providing an enclosure, said enclosure forming a protective environment for the application of said mixture;
 - regulating the atmosphere within said enclosure;
 - providing said mixture to an application device located within said enclosure;
 - placing said one or more thermoplastic polyolefin elements within said enclosure;
 - applying said mixture to said one or more thermoplastic polyolefin elements via said adhesion promoter application device; and
 - drying said one or more thermoplastic polyolefin elements after application of said mixture;
- whereby a dried layer of said adhesion promoter is retained on the surface of said one or more thermoplastic polyolefin elements; and
- wherein the presence of said dried layer of adhesion promoter does not have a detrimental effect on the appearance of said subsequently applied coating material.

2. The method of claim 1, wherein said mixture is applied to said thermoplastic polyolefin elements by at least one nozzle that is part of said adhesion promoter application device.
3. The method of claim 1, wherein the average flow rate of said mixture through said at least one nozzle is between about 0.5-2.5 liters per minute.
4. The method of claim 2, wherein the distance between said at least one nozzle and the surface of said thermoplastic polyolefin elements is between about 0.25-14 inches.
5. The method of claim 2, wherein said adhesion promoter application device has between about 15-30 total nozzles.
6. The method of claim 2, wherein the diameter of said at least one nozzle is between approximately 0.25-0.5 inches.
7. The method of claim 2, wherein the opening diameter of said at least one nozzle is between approximately 0.5-1.0 millimeters.
8. The method of claim 2, wherein said at least one nozzle is oriented at an angle of between about 10-45 degrees relative to vertical.
9. The method of claim 8, wherein said orientation of said at least one nozzle is toward the direction of travel, if said thermoplastic polyolefin elements travel through said application of said mixture.
10. The method of claim 1, further comprising moving said thermoplastic polyolefin elements through the application of said mixture by said adhesion promoter application device.

11. The method of claim 10, wherein the linear velocity of said thermoplastic polyolefin elements is between about 1-5 meters per minute.
12. The method of claim 10, wherein said thermoplastic polyolefin elements are oriented at an angle away from the direction of application of said mixture, if said mixture is applied at an angle.
13. The method of claim 11, wherein said angle is between about 5-20 degrees.
14. The method of claim 1, further comprising cleaning said thermoplastic polyolefin elements prior to said application of said mixture.
15. The method of claim 14, further comprising rinsing said thermoplastic polyolefin elements with de-ionized water prior to application of said mixture.
16. The method of claim 1, further comprising adjusting the temperature of said thermoplastic polyolefin elements to approximately the temperature of the portion of said enclosure that houses said adhesion promoter application device.
17. The method of claim 16 wherein said temperature is between about 20-25°C.
18. The method of claim 1, further comprising maintaining the relative humidity within said enclosure at between approximately 40-70%.
19. The method of claim 1, wherein the amount of said adhesion promoter mixed with said water is regulated by a metering device.

20. The method of claim 19 wherein a surface tension meter is adapted to analyze a wet sample of said mixture, said surface tension meter communicating with said metering device to provide regulation of the amount of said adhesion promoter added to said water based on said analysis
21. The method of claim 1, further comprising providing a storage device for receiving an amount of said mixture.
22. The method of claim 21, further comprising re-circulating said mixture within said storage device.
23. The method of claim 22, further comprising filtering said mixture during said re-circulation.
24. The method of claim 1, further comprising passing said mixture through a heat exchanger to regulate the temperature of said mixture prior to application by said adhesion promoter application device.
25. The method of claim 24, wherein said means for supplying said mixture to said application device supplies said mixture from said heat exchanger to said adhesion promoter application device.
26. The method of claim 25, wherein said means for supplying said mixture to said application device supplies said mixture from said heat exchanger to a gravity tank.
27. The method of claim 26, wherein said gravity tank supplies said mixture to a supply header located within said enclosure.

28. The method of claim 27, wherein said supply header has at least one nozzle extending therefrom and in communication with said mixture located therein, said supply header and said at least one nozzle forming at least a portion of said adhesion promoter application device.

29. The method of claim 1, further comprising the use of at least a partial seal for sealing each end of said enclosure.

20. The method of claim 29, wherein said at least a partial seal is an air seal.

31. The method of claim 30, wherein said air seal is provided by a fan.

32. The method of claim 1, wherein said drying of said thermoplastic polyolefin elements occurs in an oven.

33. The method of claim 32, wherein the temperature within said oven is between about 45-95°C.

34. The method of claim 32, wherein the relative humidity within said oven is between about 5-25%.

35. The method of claim 32, wherein said thermoplastic polyolefin elements enter a pre-oven prior to entering said oven.

36. The method of claim 35, wherein the temperature within said pre-oven is between about 25-65°C.

37. The method of claim 35, wherein the relative humidity within said pre-oven is between about 15-60%.

38. A method of improving adhesion between the surface of a thermoplastic polyolefin element and a subsequently applied coating material, said method comprising:

supplying a mixture of an adhesion promoter and de-ionized water;

providing an application enclosure, said enclosure forming a protective environment for the application of said mixture;

regulating the atmosphere within said application enclosure;

providing said mixture to a plurality of spray nozzles located within said application enclosure;

locating said thermoplastic polyolefin element within said application enclosure;

applying said mixture to said thermoplastic polyolefin element via said plurality of spray nozzles;

regulating, during application of said mixture to said thermoplastic polyolefin element, one or more of a flow rate of said mixture, a discharge pattern of said plurality of spray nozzles, an angle of said plurality of said spray nozzles, a distance of said plurality of spray nozzles from said thermoplastic polyolefin element, and an orientation of said thermoplastic polyolefin element; and

drying said thermoplastic polyolefin element in a drying enclosure after application of said mixture;

whereby a dried layer of said adhesion promoter is retained on the surface of said thermoplastic polyolefin element; and

wherein the presence of said dried layer of adhesion promoter does not have a detrimental effect on the appearance of said subsequently applied coating material.

39. The method of claim 38, wherein the average flow rate of said mixture through said plurality of spray nozzles is between about 0.5-2.5 liters per minute.

40. The method of claim 38, wherein the distance between said plurality of spray nozzles and the surface of said thermoplastic polyolefin element is between about 0.25-14 inches.

41. The method of claim 38, wherein there are between about 15-30 total spray nozzles.

42. The method of claim 38, wherein the diameter of said plurality of spray nozzles is between approximately 0.25-0.5 inches.

43. The method of claim 38, wherein the opening diameter of said plurality of spray nozzles is between approximately 0.5-1.0 millimeters.

44. The method of claim 38, wherein at least some of said plurality of spray nozzles are oriented at an angle of between about 10-45 degrees relative to vertical.

45. The method of claim 44, further comprising moving said thermoplastic polyolefin element through said application of said mixture by said plurality of spray nozzles.

46. The method of claim 45, wherein said angle of said at least some of said plurality of spray nozzles is toward a direction of travel of said thermoplastic polyolefin element.

47. The method of claim 45, wherein the linear velocity of said thermoplastic polyolefin element is between about 1-5 meters per minute.

48. The method of claim 45, wherein said thermoplastic polyolefin element is angled toward a direction of travel of said thermoplastic polyolefin element.

49. The method of claim 48, wherein said angle is between about 5-20 degrees.

50. The method of claim 38, further comprising cleaning said thermoplastic polyolefin element prior to said application of said mixture.

51. The method of claim 50, further comprising rinsing said thermoplastic polyolefin element with de-ionized water prior to application of said mixture.

52. The method of claim 38, further comprising adjusting the temperature of said thermoplastic polyolefin element to approximately the temperature within said application enclosure.

53. The method of claim 52, wherein said temperature is between about 20-25°C.

54. The method of claim 38, wherein said atmosphere within said application enclosure is maintained at between approximately 40-70% relative humidity.

55. The method of claim 38, wherein the amount of adhesion promoter mixed with water is regulated by a metering device.

56. The method of claim 55, wherein a surface tension meter is adapted to analyze a wet sample of said mixture, said surface tension meter communicating with said metering device to provide regulation of the amount of said adhesion promoter added to said water based on said analysis.

57. The method of claim 55, wherein said water is de-ionized water.

58. The method of claim 38, further comprising providing a storage device for receiving and storing an amount of said mixture.

59. The method of claim 58, further comprising re-circulating said mixture within said storage device.

60. The method of claim 59, further comprising filtering said mixture during re-circulation.

61. The method of claim 38, further comprising passing said mixture through a heat exchanger to regulate the temperature of said mixture prior to application by said plurality of spray nozzles.

62. The method of claim 61, wherein a pump supplies said mixture from said heat exchanger to said plurality of spray nozzles.

63. The method of claim 61, wherein a pump supplies said mixture from said heat exchanger to a gravity tank.

64. The method of claim 53, wherein said gravity tank supplies said mixture to a supply header located within said enclosure.

65. The method of claim 65, wherein said plurality of spray nozzles are in communication with said mixture located in said supply header.

66. The method of claim 38, further comprising the use of at least a partial seal for sealing each end of said enclosure.

67. The method of claim 68, wherein said seal is an air seal.

68. The method of claim 67, wherein said air seal is provided by a fan.

69. The method of claim 38, wherein the temperature within said separate drying enclosure is between about 45-95°C.

70. The method of claim 38, wherein the relative humidity within said separate drying enclosure is between about 5-25%.

71. The method of claim 38, wherein said thermoplastic polyolefin element enters a pre-oven prior to entering said drying enclosure.

72. The method of claim 71, wherein the temperature within said pre-oven is between about 25-65°C.

74. The method of claim 71, wherein the relative humidity within said pre-oven is between about 15-60%.

74. A method of improving adhesion between a thermoplastic polyolefin element and a subsequently applied coating material by depositing a layer of an adhesion promoter on the surface of said element, said method comprising:

supplying an adhesion promoter;

forming an adhesion promoter mixture from said adhesion promoter and de-ionized water;

providing a mixture storage tank for receiving and storing a supply of said mixture;

transferring at least a portion of said mixture to said mixture storage tank;

providing a mixture application enclosure, said mixture application enclosure having a regulated atmosphere and forming a protective environment around said thermoplastic polyolefin element during application of said mixture thereto;

providing a gravity tank for receiving a supply of said mixture from said mixture storage tank;

providing at least one supply header for receiving, via gravity from said gravity tank, an amount of said mixture;

providing a plurality of spray nozzles in communication with said at least one supply header, said plurality of spray nozzles adapted to be adjustable in location and direction, and to distribute said mixture received from said gravity tank over the surface of said thermoplastic polyolefin element;

locating said thermoplastic polyolefin element on a carrier;

cooling said thermoplastic polyolefin element to approximately the temperature within said mixture application enclosure;

angling at least some of said plurality of spray nozzles in a direction of travel of said conveyor;

running said thermoplastic polyolefin element through said mixture application enclosure on said conveyor while said mixture is emitted by said plurality of spray nozzles, thereby applying said mixture to said thermoplastic polyolefin element;

regulating, during application of said mixture to said thermoplastic polyolefin element, one or more of a flow rate of said mixture, a discharge pattern of said plurality of spray nozzles, a distance of said plurality of spray nozzles from said thermoplastic polyolefin element, the orientation of said thermoplastic polyolefin element on said conveyor, and the speed of said conveyor; and

passing said thermoplastic polyolefin element through a drying enclosure after application of said mixture;

whereby a dried layer of said adhesion promoter is thereafter retained on the surface of said thermoplastic polyolefin element; and

wherein, due to the application of a substantially complete coating of said thermoplastic polyolefin element with said mixture and a reduction in the amount of foaming and splashing of said mixture that occurs during said application, the presence of said dried layer of adhesion promoter does not have a detrimental effect on the appearance of said subsequently applied coating material.

75. The method of claim 74, wherein the average flow rate of said mixture through said plurality of spray nozzles is between about 0.5-2.5 liters per minute.

76. The method of claim 74, wherein the distance between said plurality of spray nozzles and the surface of said thermoplastic polyolefin element is between about 0.25-14 inches.

77. The method of claim 74, wherein there are between about 15-30 total spray nozzles.

78. The method of claim 74, wherein the diameter of said plurality of spray nozzles is between approximately 0.25-0.5 inches.

79. The method of claim 74, wherein the opening diameter of said plurality of spray nozzles is between approximately 0.5-1.0 millimeters.

80. The method of claim 74, wherein said at least some of said plurality of spray nozzles are oriented at an angle of between about 10-45 degrees relative to vertical.

81. The method of claim 74, wherein the linear velocity of said thermoplastic polyolefin element on said conveyor is between about 1-5 meters per minute.

82. The method of claim 74, wherein said thermoplastic polyolefin element is angled toward a direction of travel of said conveyor.

83. The method of claim 82, wherein said angle is between about 5-20 degrees.

84. The method of claim 74, further comprising cleaning said thermoplastic polyolefin element prior to said application of said mixture.

85. The method of claim 84, further comprising rinsing said thermoplastic polyolefin element with de-ionized water prior to application of said mixture.

86. The method of claim 74, wherein said thermoplastic polyolefin element is cooled to a temperature of between about 20-25°C.

87. The method of claim 74, wherein said atmosphere within said mixture application enclosure is maintained at between approximately 40-70% relative humidity.

88. The method of claim 74, wherein the amount of adhesion promoter mixed with water is regulated by a metering device.

89. The method of claim 88, wherein a surface tension meter is adapted to analyze a wet sample of said mixture, said surface tension meter communicating with said metering device to provide regulation of the amount of said adhesion promoter added to said water based on said analysis.

90. The method of claim 74, wherein said water is de-ionized water.

91. The method of claim 74, further comprising re-circulating said mixture within said mixture storage tank.

92. The method of claim 91, further comprising filtering said mixture during re-circulation.

93. The method of claim 74, further comprising passing said mixture through a heat exchanger to regulate the temperature of said mixture prior to application by said plurality of spray nozzles.

94. The method of claim 93, wherein a pump supplies said mixture from said heat exchanger to said gravity tank.
95. The method of claim 74, further comprising the use of an air seal for sealing each end of said mixture application enclosure.
96. The method of claim 95, wherein said air seal is provided by a fan.
97. The method of claim 74, wherein the temperature within said drying enclosure is between about 45-95°C.
98. The method of claim 74, wherein the relative humidity within said drying enclosure is between about 5-25%.
99. The method of claim 74, further comprising passing said thermoplastic polyolefin element through a pre-oven prior to its introduction to said drying enclosure.
100. The method of claim 99, wherein the temperature within said pre-oven is between about 25-65°C.
101. The method of claim 99, wherein the relative humidity within said pre-oven is between about 15-60%.